Colorado-Grand Canyon Watershed

COLORADO-GRAND CANYON WATERSHED CHARACTERISTICS

SIZE	16,437 square miles (14% of the State's land area).					
POPULATION BASE	Approximately 67,500 people live in this watershed (estimated from the 2000 census). This is about 1.5% of the state's population.					
LAND OWNERSHIP **(Figure 9)**	Bureau of Land Management	32%	Tribal land	22%	National Parks and Monuments	15%
	Private land	13%	U.S. Forest Service	10%	State Land Dept.	8%
LAND USES AND PERMITS **(Figure 10)**	Most of this watershed is sparsely populated. The largest communities are Kingman and Williams. Land use is primarily a mixture of open grazing, recreation, and silviculture, with scattered mineral districts. This watershed contains the Grand Canyon National Monument, Kaibab National Forest, and Lake Mead and Glen Canyon national recreational areas which all have restricted land uses to protect natural resources. These federal lands also draw a large number of tourists and recreationists.					
HYDROLOGY AND GEOLOGY	This watershed is defined by the Colorado River drainage area within Arizona from Lake Powell to Hoover Dam at Lake Mead, excluding the Little Colorado River drainage through the Grand Canyon National Monument. The Colorado River and many of its tributaries (near their confluence with the Colorado River) are perennial; however, most of the streams in the watershed are ephemeral or intermittent (Brown et al. 1978). The flow in the Colorado River at Lee's Ferry has an average discharge of 17,850 cfs, with a maximum discharge of 97,300 cfs (in 1983). Prior to completion of Glen Canyon Dam in 1963 the maximum flow was about 300,000 cfs (since 1868) (USGS 1996). Several ground water basins are included in this watershed, including: the Coconino Plateau, Detrital Valley, Grand Wash, Hualapai Valley, Kanab Plateau, Meadview, Paria, Peach Springs, Shivwits Plateau, and Virgin River basins, along with minor portions of Big Sandy, Lake Mohave, and the Little Colorado River basins Verde Watershed. The area contains incised canyons formed by erosion of sedimentary formations, volcanically formed mountains, and high plateaus, valleys, and mountain canyons. Aquifers with low water-yields are contained in fractured limestones, sandstones, shales, and igneous rocks. High water-yield aquifers are typically found in alluvium and basin fill deposits in valleys and along rivers. (ADWR 1994) Elevations range from 1,000 feet above sea level along the Colorado River to 12,600 feet at the San Francisco Peaks. Most of the watershed is included in the Plateau Uplands Province (upper elevations), with a portion of the Basin and Range Province (lower elevations)					
UNIQUE WATERS	None					
ECOREGIONS	Primarily the Arizona-New Mexico Plateau, with Arizona-New Mexico Mountains on the eastern edge and Southern Basin and Range on the western edge .					
OTHER STATES, NATIONS, TRIBES	This watershed receives drainage from Utah, Colorado, Wyoming, and New Mexico to the north and Nevada to the west. It discharges to the Colorado-Lower Gila Watershed to the south. Hualapai, Havasupai, Kaibab-Paiute, and Navajo tribal lands occur within this watershed.					

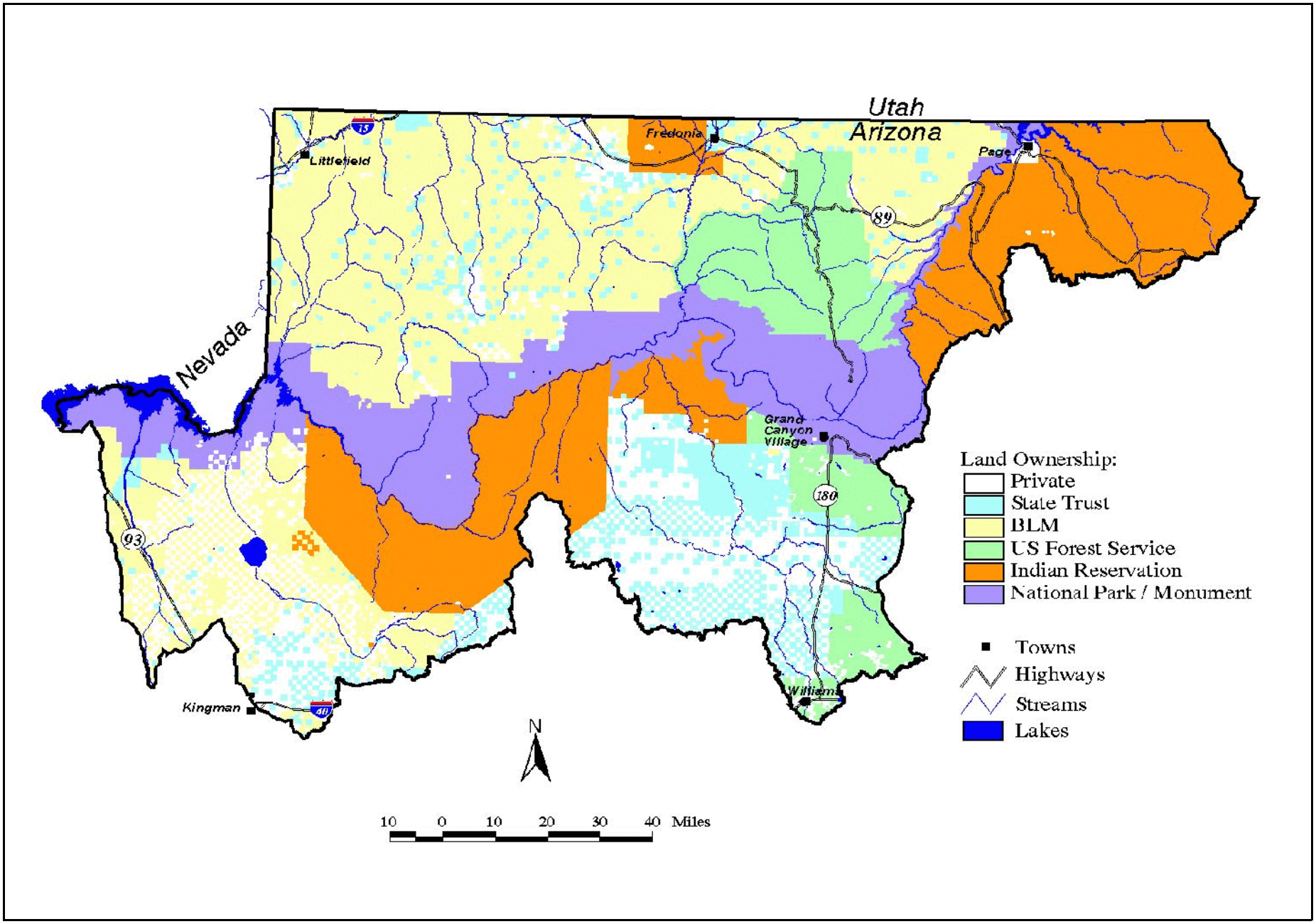

Figure 9. Land Ownership in the Colorado-Grand Canyon Watershed

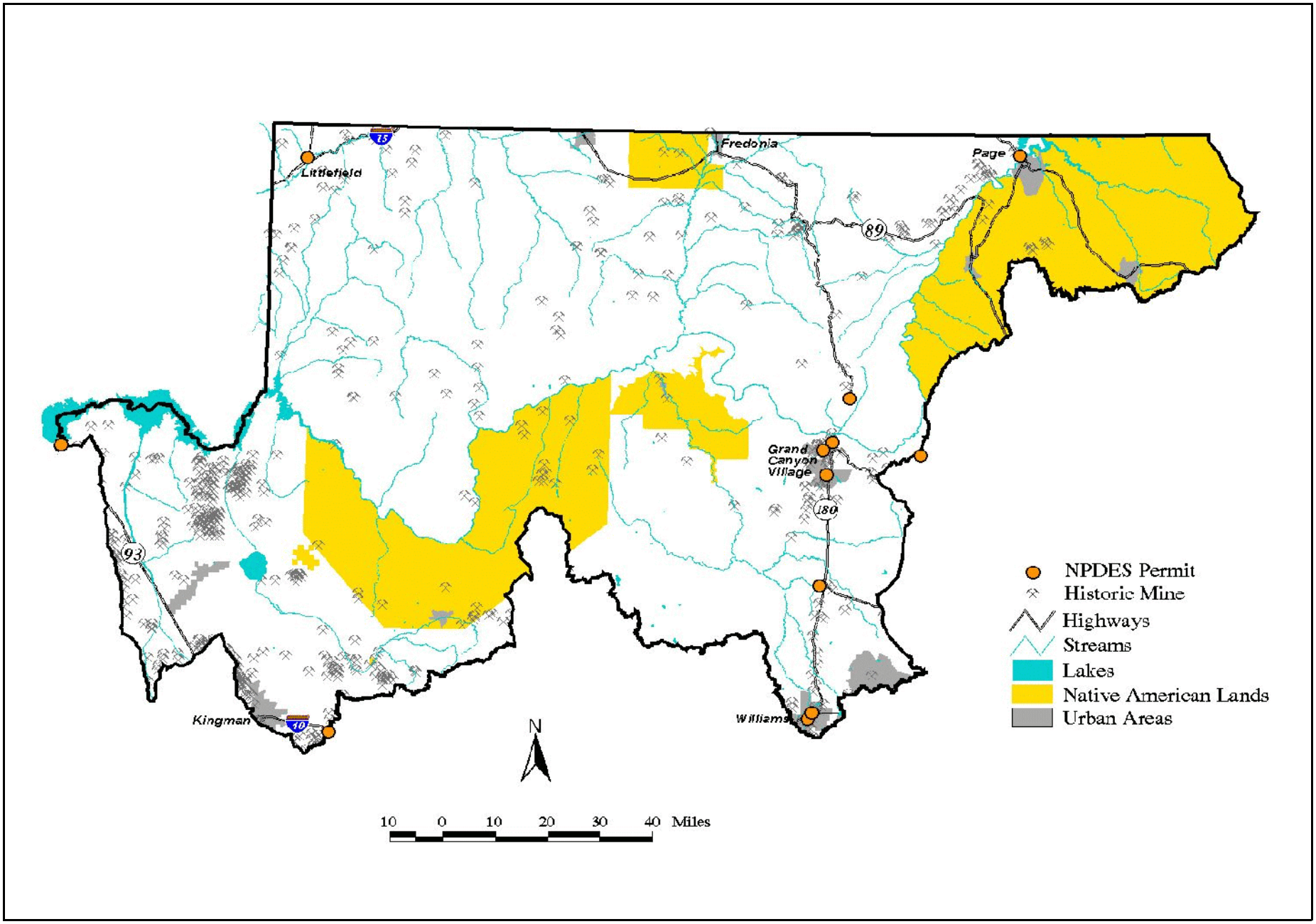

Figure 10. General Land Use and NPDES Permits in the Colorado-Grand Canyon Watershed

Colorado-Grand Canyon Watershed Assessment Discussion

Statistical Summary of Surface Water Assessments

Assessments – For the 2002 assessment, 94 stream miles and 9,770 lake acres were assessed. Fewer assessments were completed than previously because of two factors: 1) changes in assessment criteria requiring more data to base an assessment and documented sampling analysis plans, and 2) a lack of current credible water quality data. This watershed will be a focus for additional monitoring in 2004.

Water quality assessment information for the Colorado-Grand Canyon Watershed is summarized in the following tables and illustrated in **Figure 11**.

Table 6. Assessments in the Colorado-Grand Canyon Watershed – 2002

	STREAMS		LAKES	
	miles	number of segments	acres	number of lakes
ATTAINING	46	2	0	0
INCONCLUSIVE	10	1	9,770	1
IMPAIRED	38	2	0	0
NOT ATTAINING			0	0
TOTAL ASSESSED	94	5	9,770	1

PERENNIAL SURFACE WATERS ASSESSED		STREAMS		LAKES	
		miles	number of segments	acres	number of lakes
	Assessed	84	4	9,770	1

* Note that streams with significant perennial stretches within the reach assessed were included in the perennial milage although part of the reach may have ephemeral or intermittent flow.

Inconclusive Assessments – Surface waters with some monitoring data but insufficient data to determine if the water is attaining its uses or impaired were added to ADEQ's new Planning List. By the end of the focused watershed monitoring (scheduled in 2004), ADEQ expects to monitor most of these reaches so they can be assessed during future assessment cycles. Other lakes and streams which lack water quality data will also be monitored depending on resources and priorities.

As indicated in the monitoring data table that follows, the data acquired from the National Park Service did not meet new credible data requirements for these surface water assessments because a Quality Assurance Plan and Sampling Analysis Plan were not available. The data also did not include a significant number of core parameters, so that even if the data had been used, no designated uses could have been assessed as attaining uses. There were also insufficient samples to determine if the water was impaired if there were any standards exceeded. ADEQ will be coordinating with this agency to encourage additional monitoring documentation needed to meet Arizona's new requirements for all future monitoring.

Major Stressors – When a surface water is listed as impaired or TMDL approved, the pollutants or suspected pollutants causing the impairment are identified. Only two reaches are to be listed as impaired in this watershed. One reach along the Virgin River and one along the Colorado River. Both were impaired by turbidity. The Virgin River was also impaired by fecal coliform.

TMDL investigations are needed to determine the sources of these pollutants and the extent that natural background contributes to these exceedances.

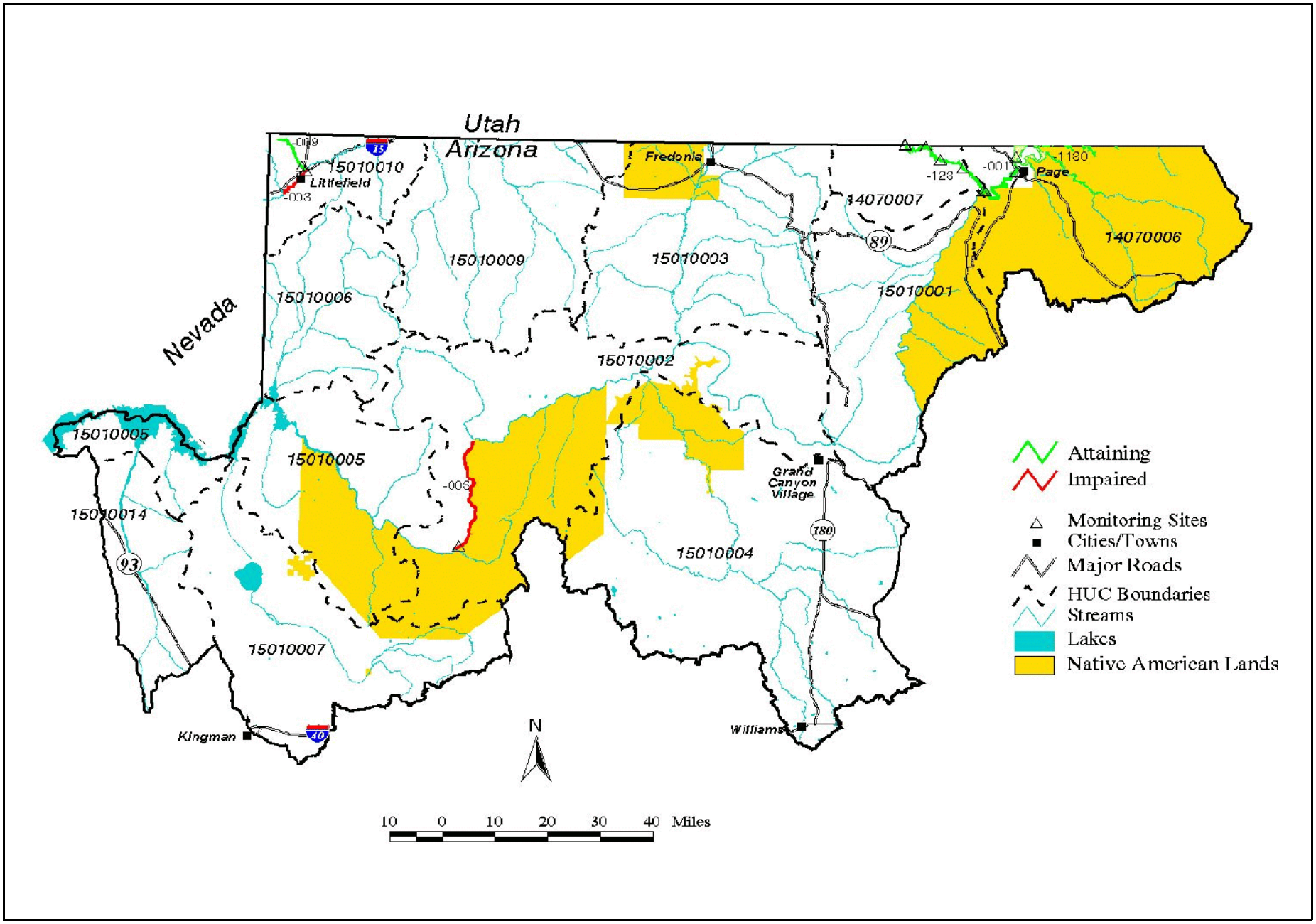

Figure 11. Colorado-Grand Canyon Watershed Surface Water Assessments – 2002

TABLE 7. COLORADO - GRAND CANYON WATERSHED – 2002 ASSESSMENT – MONITORING DATA TABLE								
STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	**AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID**	**YEAR SAMPLED NUMBER AND TYPE OF SAMPLES**	**STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT**					
			PARAMETER UNITS	**STANDARD (DESIGNATED USE)**	**RANGE OF RESULTS (MEAN)**	**FREQUENCY EXCEEDED STANDARD**	**PARAMETRIC USE SUPPORT**	**COMMENTS**
STREAM MONITORING DATA								
Beaver Dam Wash, Utah border-Virgin River AZ15010010-009 A&Ww, FC, FBC, AgI, AgL	ADEQ Fixed Station Network Above Virgin River CMBDW000.08 100452	1997 - 1 suite	OK					
	ADEQ Fixed Station Network Below R. Lyon's Property CMBDW000.49 100451	1997 - 1 suite	OK					
	ADEQ Fixed Station Network Below Hwy 91 bridge CMBDW000.73 100449	1997 - 1 suite	OK					
	ADEQ Fixed Station Network At right bank spring CMBDW000.913 100446	1997 - 1 suite	Dissolved oxygen mg/L	6.0 90% saturation (A&Ww)	5.8 (55%)	1 of 1		Field staff documented that naturally occurring ground water upwelling from spring sources, rather than any anthropogenic activities, caused the low dissolved oxygen; therefore, not considered in the final assessment.
	ADEQ Fixed Station Network At left bank spring CMBDW000.918 100448	1997 - 1 suite	Dissolved oxygen mg/L	6.0 90% saturation (A&Ww)	5.8 (45%)	1 of 1		
	Reach Summary Row **A&Ww Inconclusive FC Inconclusive FBC inconclusive AgI Inconclusive AgL Inconclusive**	**1997** **5 samples 1 sampling event**	**OK**				**Inconclusive**	**ADEQ collected a total of 5 samples at 5 sites during 1 sampling event in 1997. Assessed as "inconclusive" as a minimum of 3 sampling events are needed to as "attaining" uses.**
Boucher Creek California-Colorado River AZ15010002-017 A&Wc, FC, FBC	National Park Service Routine Monitoring Below camp, near Tonto Trail CMBOU000.67	1997 - 1 field 1998 - 1 field	OK					National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and insufficient sampling events to support assessments.
	Reach Summary Row		**OK**				**Not assessed**	**Insufficient credible data.**

TABLE 7. COLORADO - GRAND CANYON WATERSHED – 2002 ASSESSMENT – MONITORING DATA TABLE								
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			PARAMETER UNITS	**STANDARD (DESIGNATED USE)**	**RANGE OF RESULTS (MEAN)**	**FREQUENCY EXCEEDED STANDARD**	**PARAMETRIC USE SUPPORT**	**COMMENTS**
Chuar (Lava) Creek headwater-Colorado River AZ15010001-024 A&Wc, FC, FBC	National Park Service Routine Monitoring Near Colorado River (Lava Cyn) CMCHU000.22	1996 - 1 field 1998 - 1 field	Turbidity NTU	10 (A&Wc)	165-884	2 of 2		Turbidity determined to be due to erosion of natural sandstone formations rather and not human caused. National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Clear Creek headwaters-Colorado River AZ15010001-025 A&Wc, FC, FBC	National Park Service Routine Monitoring At confluence with Colorado River CMCLE000.03	1996 - 1 field 1997 - 1 field 1998 - 1 field	OK					National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Colorado River Lake Powell-Paria River AZ14070006-001 A&Wc, FC, FBC, DWS, AgI, AgL	USGS Station #09379910 Below Glen Canyon Dam CMCLR333.55	1997 - 2 suites	OK					Missing core parameters
	USGS Station #09380000 At Lee's Ferry CMCLR327.39 100743	1996 - 10 suites 1997 - 4 suites 1998 - 6 suites 1999 - 6 suites 2000 - 7 suites	OK					
	Bureau of Reclamation and /Utah Dept. of Env. Quality Lake Powell Monitoring Below Glen Canyon Dam CMCLR333.61	1996-1998 - 33 suites	OK					Limited parameters (no metals)
	Reach Summary Row **A&Ww Attaining** **FC Attaining** **FBC Attaining** **AgI Attaining** **AgL Attaining**	**1996-2000** **68 sampling events**	**OK**				**Attaining**	**US Geological Survey, Bureau of Reclamation and the Utah DEQ collected a total of 68 samples at 3 sites in 1996-2000. The reach is assessed as" attaining all uses."**
Colorado River Parashant-Diamond AZ15010002-003 A&Wc, FC, FBC, DWS, AgI, AgL	USGS Station #09404200 Above Diamond Creek CMCLR233.40 100751	1997 - 9 suite 1998 - 8 suite 1999 - 9 suite 2000 - 5 suite	Turbidity NTU	10 (A&Wc)	1.3-1000	15of 32		Missing core parameters: total mercury, arsenic, beryllium, manganese, boron, copper, and lead, and Escherichia coli.

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			PARAMETER UNITS	**STANDARD (DESIGNATED USE)**	**RANGE OF RESULTS (MEAN)**	**FREQUENCY EXCEEDED STANDARD**	**PARAMETRIC USE SUPPORT**	**COMMENTS**
	Reach Summary Row **A&Ww Impaired** **FC Inconclusive** **FBC Inconclusive** **DWS Inconclusive** **AgI Inconclusive** **AgL Inconclusive**	**1997-2000** **31 sampling events** **Missing core parameters**	**Turbidity NTU**	**10 (A&Wc)**	**1.3-1000**	**15of 32**	**Impaired**	**US Geological Survey monitoring at one site for a total of 31 sampling events. Reach is assessed as "impaired" due to turbidity. Reach also added to the Planning List due to insufficient core parameters.**
Cottonwood Creek headwaters-Colorado River AZ15010001-026 A&Ww, FC, FBC, AgL	National Park Service Routine Monitoring At Gage (and spring) CMCOT000.76	1997 - 1 pH	OK					National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Crystal Creek headwaters-Colorado River AZ15010002-018 A&Wc, FC, FBC	National Park Service Bioassessment Program Above Colorado River CMCRY000.05	1996 - 1 field 1997 - 1 field 1998 - 1 field, 1 bact 1999 - 1 field	OK					National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data..**
Deer Creek headwaters-Colorado River AZ15010002-019 A&Wc, FC, FBC	National Park Service Bioassessment Program At Colorado River CMDEE000.03	1996 - 2 field 1997 - 1 field 1998 - 2 field	OK					National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Garden Creek headwaters-Colorado River AZ15010002-841 A&Wc, FC, FBC	National Park Service Routine Monitoring Below Tonto Trail/ Indian Garden CMGDN001.12	1997 - 1 field 1998 - 1 field, 1 bact	OK					National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Hermit Creek headwaters-Colorado River AZ15010002-020 A&Wc, FC, FBC	National Park Service Bioassessment Program Above Colorado River CMHRM000.05	1996 - 1 field 1997 - 1 field 1998 - 1 field						National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**

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			PARAMETER UNITS	**STANDARD (DESIGNATED USE)**	**RANGE OF RESULTS (MEAN)**	**FREQUENCY EXCEEDED STANDARD**	**PARAMETRIC USE SUPPORT**	**COMMENTS**
Kanab Creek Jump-up Canyon-Colorado River AZ15010003-001 A&Ww, FC, FBC, DWS, AgL	National Park Service Bioassessment Program Above Colorado River CMKAN000.20	1996 - 1 field	OK					National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Kwagunt Creek headwaters-Colorado River AZ15010001-031 A&Wc, FC, FBC	National Park Service Routine Monitoring By Mesquite near Colorado River CMKWA000.17	1996 - 2 field 1997 - 1 field 1998 - 1 field	Turbidity NTU	10 (A&Wc)	0.65-113	1 of 4		Turbidity is due to natural erosion of sandstone formations in the Grand Canyon rather than human-caused sources. National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Monument Creek headwaters-Colorado Rive AZ15010002-845 A&Ww, FC, FBC	National Park Service Routine Monitoring At Colorado River CMMON000.08	1996 - 1 field 1997 - 1 field 1998 - 1 field	Dissolved oxygen mg/L	6.0 90% saturation (A&Ww)	3.5-8.1 46-96%	1 of 3		Field staff documented that naturally occurring ground water upwelling rather than any anthropogenic activities caused the low dissolved oxygen; therefore, data not considered in the final assessment.. National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Nankoweap Creek headwaters-Colorado River AZ15010001-033 A&Wc, FC, FBC	National Park Service Routine monitoring Above Confluence CMNAN000.09	1998 - 2 field 1997 - 1 field 1998 - 2 field	Turbidity NTU	10 (A&Wc)	65.6	1 of 5		National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
National Canyon Creek headwaters-Colorado River AZ15010002-016 A&Wc, FC, FBC	National Park Service Routine monitoring Above Colorado River CMNAT000.34	1997 - 1 field 1998 - 2 field	Turbidity NTU	10 (A&Wc)	16-24.5	3 of 3		Field staff documented that turbidity is due to naturally occurring erosion of sandstone formations in this pristine drainage area of the Grand Canyon rather than anthropogenic sources; therefore, data were not included in the final assessment.. National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**

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			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	PARAMETRIC USE SUPPORT	COMMENTS
Paria River Utah-Colorado River AZ14070007-123 A&Wc, FC, FBC	ADEQ TMDL Program Site 7 at Lees' Ferry CMPAR000.55 101073	1999 - 4 suite 2000 - 6 suite, 1 metals	Dissolved oxygen mg/L	7.0 (90% saturation) (A&Wc)	4.3-8.2 (0%)	7 of 10		Field staff documented that naturally occurring ground water upwelling (generally flow is from spring sources) rather than any anthropogenic activities caused the low dissolved oxygen; therefore, data not considered in the final assessment.
			Turbidity NTU	10 (A&Wc)	6.8-441	8 of 10		Investigation showed that high turbidity is solely due to natural erosion of sandstone cliffs. Data not used in final assessment.
	Northern Arizona University Paria TMDL Monitoring Site 5. - 25 km below Buckskin G. Site 6 - 37.5 km below Buckskin Site 7- 50 km below Buckskin G. Part of Seven sites along the Paria River and Buckskin Gulch,	1999 - 4 field, dissolved metals – each site 2000 - 6 field, dissolved metals – each site	Beryllium µg/L	0.21 (FC) 4.0 (FBC)	<0.1 - 17.3	21 of 30 3 of 30		Metals data did not meet credible data requirements due to lapses in quality control/ protocols (testing after holding times expired).
			Dissolved oxygen mg/L	7.0 (A&Wc)	4.0 - 10.7	14 of 30		Investigation shows that low dissolved oxygen and high turbidity are solely due to natural conditions (see comment at first site).
			Turbidity NTU	10 (A&Wc)	6 - 441	23 of 30		
	ADEQ TMDL Program Site 6 at mile marker 22.5 CMPAR007.95 101074	1999 - 4 suite 2000 - 6 suite, 1 metals	Dissolved oxygen mg/L	7.0 (90% saturation) (A&Wc)	4.3-9.1 (0%)	4 of 10		Investigation shows that low dissolved oxygen and high turbidity are solely due to natural conditions (see comment at first site).
			Turbidity NTU	10 (A&Wc)	6.2-441	8 of 10		
	ADEQ TMDL Program Site 5 at mile marker 15 CMPAR013.79 101075	1999 - 4 suite 2000 - 6 suite, 2 metals	Dissolved oxygen mg/L	7.0 (90% saturation) (A&Wc)	4-10.7 (0%)	3 of 10		Investigation shows that low dissolved oxygen and high turbidity are solely due to natural conditions (see comment at first site).
			Turbidity NTU	10 (A&Wc)	6.0-441	8 of 10		
	ADEQ TMDL Program Site 4 at mile marker 7.5 CMPAR022.37 101076	1999 - 4 suite 2000 - 6 suite, 1 metals	Arsenic µg/L	360 (A&Wc) 50 (FBC)	2-425	1 of 11 1 of 11		
			Dissolved oxygen mg/L	7.0 (90% saturation) (A&Wc)	4.8-10.6 (0%)	6 of 10		Investigation shows that low dissolved oxygen and high turbidity are solely due to natural conditions (see comment at first site).
			Turbidity NTU	10 (A&Wc)	4.2-441	8 of 10		
	ADEQ TMDL Program Site 3 below confluence CMPAR029.87 101077	1999 - 4 suite 2000 - 6 suite, 1 metals	Dissolved oxygen mg/L	7.0 (90% saturation) (A&Wc)	4.3-9.1 (0%)	3 of 9		Investigation shows that low dissolved oxygen and high turbidity are solely due to natural conditions (see comment at first site).

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			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	PARAMETRIC USE SUPPORT	COMMENTS
			Turbidity NTU	10 (A&Wc)	6.2-441	7 of 10		
			Arsenic µg/L	50 (FBC)	<2-96.3	1 of 10		
			pH SU	6.5-9.0 (A&Wc, FBC)	8/04-9.32	1 of 9		
	ADEQ TMDL Program Site 2 above Colorado River CMPAR029.90 101078	1999 - 4 suite 2000 - 6 suite, 1 metals	Dissolved oxygen mg/L	7.0 (90% saturation) (A&Wc)	3.9-14.8 (0%)	3 of 10		Investigation shows that low dissolved oxygen and high turbidity are solely due to natural conditions (see comment at first site).
			Turbidity NTU	10 (A&Wc)	0.8-441	6 of 10		
			Arsenic µg/L	50 (FBC)	<2-76.7	2 of 11		
	ADEQ TMDL Program Site 1 Buckskin Gulch CMPAR030.00 101079	1999 - 4 suite 2000 - 6 suite, 1 metals	Dissolved oxygen mg/L	7.0 (90% saturation) (A&Wc)	5.4-9.4 (0%)	1 of 10		Investigation shows that low dissolved oxygen and high turbidity are solely due to natural conditions (see comment at first site).
			Turbidity NTU	10 (A&Wc)	0.9-34	2 of 10		
			Arsenic µg/L	50 (FBC)	<2-129.5	3 of 10		
	Northern Arizona University Paria TMDL Monitoring Site 2 - 10 meters above Buckskin Site 3 - 10 meters below Buckskin Site 4 - 12.5 m below Buckskin G. Part of Seven sites along the Paria River and Buckskin Gulch,	1999 - 4 field, dissolved metals – each site 2000 - 6 field, dissolved metals - each site	Arsenic µg/L	50 (FBC)	<2.0 - 457.7	2 of 30		Metals data did not meet credible data requirements due to lapses in quality control/ protocols (testing after holding times expired). Naturally occurring low dissolved oxygen (see notes in first site). Data not used in final assessment.
			Beryllium µg/L	0.21 (FC) 4.0 (FBC)	<0.1 - 38.4	22 of 30 7 of 30		
			Dissolved oxygen mg/L	7.0 (A&Wc)	4.8 - 10.6	12 of 30		
			Turbidity NTU	10 (A&Wc)	0.8 - 441	21 of 30		
	Reach Summary Row **A&Wc Attaining** **FC Attaining** **FBC Attaining**	**1999-2000** **82 samples** **7 sampling events**	**Arsenic µg/L**	**360 (A&Wc) 50 (FBC)**	**<2-457.7**	**1 of 75 6 of 75**	**Attaining Attaining**	**ADEQ's TMDL Program collected samples at 7 sites. Reach assessed as "attaining all uses." Note that low dissolved oxygen levels and high turbidity were found to be solely due to natural sources.**
			pH SU	**6.5-9.0 (A&Wc, FBC)**	**8/04-9.32**	**1 of 70**	**Attaining**	
Pumpkin Springs At Colorado River AZ15010002-SP01 A&Ww, FC, FBC, DWS, AgI, AgL	National Park Service Routine Monitoring Above Colorado River CMSPR3	1998 - 1 field	OK					National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.

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			PARAMETER UNITS	**STANDARD (DESIGNATED USE)**	**RANGE OF RESULTS (MEAN)**	**FREQUENCY EXCEEDED STANDARD**	**PARAMETRIC USE SUPPORT**	**COMMENTS**
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Royal Arch Creek headwaters-Colorado River AZ15010002-871 A&Wc, FC, FBC	National Park Service Routine monitoring Above Colorado River CMRYA000.23	1996 - 2 field 1997 - 1 field 1998 - 1 field 1999 - 1 field	OK					National Park Service data did not meet new “credible data” requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Saddle Canyon Creek headwaters-Colorado River AZ15010002-703 A&Wc, FC, FBC	National Park Service Routine Monitoring Near Tapeats, below falls CMSAD000.16	1996 - 1 field 1997 - 1 field 1998 - 1 field 1999 - 1 field	OK					National Park Service data did not meet new “credible data” requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Shinumo Creek headwaters-Colorado River AZ15010002-029 A&Wc, FC, FBC	National Park Service Routine Monitoring Colorado River, @ Trail crossing CMSHI000.06	1996-- 1 field 1997 - 1 field 1998 - 1 field	OK					National Park Service data did not meet new “credible data” requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Spring Canyon Creek headwaters-Colorado River AZ15010002-318 A&Wc, FC, FBC	National Park Service Routine monitoring Above Colorado River CMSPG000.24	1996 - 1 field 1997 - 1 field 1998 - 1 field 1999 - 1 field	OK					National Park Service data did not meet new “credible data” requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Stone Creek headwaters-Colorado River AZ15010002-030 A&Wc, FC, FBC	National Park Service Routine Monitoring At Colorado River, below falls CMSTO000.14	1997 - 1 field	OK					National Park Service data did not meet new “credible data” requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Tapeats Creek headwaters-Colorado River AZ15010002-696 A&Wc, FC, FBC	National Park Service Routine monitoring Above Colorado River CMTAP000.24	1996 - 1 field 1998 - 1 field	OK					National Park Service data did not meet new “credible data” requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**

TABLE 7. COLORADO - GRAND CANYON WATERSHED – 2002 ASSESSMENT – MONITORING DATA TABLE								
STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	**AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID**	**YEAR SAMPLED NUMBER AND TYPE OF SAMPLES**	**STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT**					
			PARAMETER UNITS	**STANDARD (DESIGNATED USE)**	**RANGE OF RESULTS (MEAN)**	**FREQUENCY EXCEEDED STANDARD**	**PARAMETRIC USE SUPPORT**	**COMMENTS**
Three Springs Creek headwaters-Colorado River AZ15010002-1180 A&Wc, FC, FBC, DWS, AgI, AgL	National Park Service Routine monitoring Above Colorado River CMTHS000.04	1996 - 1 field 1997 - 1 field 1998 - 1 field	OK					National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Thunder River headwaters-Tapeats Creek AZ15010002-732 A&Wc, FC, FBC	National Park Service Routine Monitoring Below Cave, @ Tapeats CMTHR000.38	1999 - 1 field	OK					National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Vasey's Paradise (Spring) At Colorado River AZ15010001-SP01 A&Wc, FC, FBC	National Park Service Routine Monitoring Below Spring CMSPR1	1996 - 2 field 1997 - 1 field 1998 - 1 field 1999 - 1 field	OK					National Park Service data did not meet new "credible data" requirements. Also insufficient core parameters and sampling events for assessments.
	Reach Summary Row						**Not assessed**	**Insufficient credible data.**
Virgin River Beaver Dam Wash-Big Bend W. AZ15010010-003 A&Ww, FC, FBC, AgI, AgL	USGS Station # 9415000 At Littlefield, Az CMVGR010.18	1996 - 5 suite 1997 - 6 suite 1998 - 6 suite 1999 - 6 suite Missing total mercury, arsenic, beryllium manganese, boron, and copper.	Fecal coliform CFU/100/ml	4000 (A&Ww, AgI, AgL)	19-240,000	2 of 15		2 exceedances occurred in a 3-year period.
			Escherichia coli CFU/100/ml	580 (FBC)	12-3000	1 of 5		Not sampled for *E. coli* in 1996-1998.
			Turbidity NTU	50 (A&Ww)	0.3-360	8 of 23		Naturally occurring erosion of sandstone formations may be the cause of turbidity.
	Reach Summary Row **A&Ww Impaired** **FC Inconclusive** **FBC Inconclusive** **AgI Impaired** **AgL Impaired**	**1996-1999** **23 samples** **Missing core parameters**	**Escherichia coli CFU/100/ml**	**580 (FBC)**	**12-3000**	**1 of 5**	**Inconclusive**	**US Geological Service collected 23 samples in 1996-1999. Reach assessed as impaired due to turbidity and bacteria. Reach put on Planning List due to missing core parameters.**
			Fecal coliform CFU/100 ml	**4000 (A&Ww, AgI, AgL)**	**19-240,000**	**2 of 15 2 in 3-years**	**Impaired**	
			Turbidity NTU	**50 (A&Ww)**	**0.3-360**	**8 of 23**	**Impaired**	
LAKES MONITORING DATA								
Lake Powell AZL14070006-1130 A&Wc, FC, FBC, DWS, AgI, AgL	Bureau of Rec. Selenium Investigation 4 sites CMPOW	1996 - 4 selenium 1997 - 1 selenium 1998 - 3 selenium 1999 - 3 selenium	OK					Exceeds chronic selenium standard occasionally (12 of 49 samples). Median did not exceed chronic standard.

TABLE 7. COLORADO - GRAND CANYON WATERSHED – 2002 ASSESSMENT – MONITORING DATA TABLE								
STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	**AGENCY PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID**	**YEAR SAMPLED NUMBER AND TYPE OF SAMPLES**	**STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT**					
			PARAMETER UNITS	**STANDARD (DESIGNATED USE)**	**RANGE OF RESULTS (MEAN)**	**FREQUENCY EXCEEDED STANDARD**	**PARAMETRIC USE SUPPORT**	**COMMENTS**
	Glen Canyon Natl. Rec. Area Bact Monitoring Network CMPOW - AP2	1995 - 17 bact 1996 - 16 bact 1997 - 9 bact 1998 - 10 bact	OK					
	Glen Canyon Natl. Rec. Area Bact Monitoring Network CMPOW - NPS1	1996 - 12 bact	OK					
	Glen Canyon Natl. Rec. Area Bact Monitoring Network CMPOW - STATE1	1996 - 12 bact 1997 - 8 bact 1998 - 10 bact 1999 - 8 bact	OK					
	Glen Canyon Natl. Rec. Area Bact Monitoring Network CMPOW - WWB1	1996 - 16 bact 1997 - 10 bact 1998 - 10 bact 1 1999 - 10 bact	OK					
	Glen Canyon Natl. Rec. Area Bact Monitoring Network CMPOW - WWM1	1998 - 10 bact 1999 - 10 bact	OK					
	Glen Canyon Natl. Rec. Area Bact Monitoring Network CMPOW - WWPB1	1996 - 27 bact 1997 - 9 bact 1998 - 10 bact 1999 - 8 bact	OK					
	Glen Canyon Natl. Rec. Area Bact Monitoring Network CMPOW - WWPB2	1996 - 9 bact	OK					
	Reach Summary Row **A&Ww Inconclusive** **FC Inconclusive** **FBC Inconclusive** **DWS Inconclusive** **AgI Inconclusive** **AgL Inconclusive**	**1996-1997** **68 sampling events** **Missing core parameters.**	OK				**Inconclusive**	**Bureau of Recreation and Glen Canyon Natural Recreation Area collected a total of 68 samples at 11 sites on Lake Powell in Arizona. Insufficient core parameters monitored to assess uses.**

Information for interpreting these Monitoring Tables

- "Segment" designates the beginning and end points of the reach.
- "Waterbody ID" is derived from combining the following: AZ (for streams) or AZL (for lakes) + a US Geological Survey Hydrologic Unit Code + EPA stream reach number or ADEQ lake number.
- "Designated Uses," "Agency," and "Units" (of measurement) abbreviations are defined in Appendix A.
- "Site Code" is an ADEQ derived abbreviation for the surface water basin, stream name or lake name, and the location of the site. For streams, the numbers are the miles upstream from mouth (normally measured as a straight line vector).
- "ADEQ Database ID" -- This is ADEQ's water quality database reference number. If the data is not in this database, no number will be shown.
- "Samples" -- The year and number of water samples is shown. The federal "water year" is used, from October 1st through September 30th, rather than the calendar year. Types of samples:
  - < "Suite" indicates that a broad range of chemical constituents were collected and field measurements were taken (normally inorganics, metals, nutrients, and bacteria.) The chemical constituents monitored are not consistent among the many monitoring entities that provided the data. If the suite did not include the core parameters needed to assess a designated use as "attaining," the missing core parameters are indicated.
  - < "Field" indicates that only field measurements such as dissolved oxygen, pH, turbidity, and water temperature were collected.
  - < If a specific parameter or parametric group (e.g., zinc, metals, bacteria) is named, monitoring was limited to only these parameters
- "Standards Exceeded at this Site per Sampling Event."
  - < Although many parameters may be analyzed, only those exceeding a standard are shown. Other parameters were collected.
  - < "OK" indicates that no standards were exceeded.
  - < The specific standards are shown as a single parameter may have multiple standards depending on the designated uses assigned. (See standards in Appendix C.)
  - < "The Range of Results" indicates the minimum and maximum sample results. If the laboratory reported result is "less than the detection limit" or "not detected," a less than (<) value will be shown along with the detection limit (e.g., <0.5 mg/L).
  - < A mean, geometric mean, or median will be shown along with the range of results if applicable to the standard or assessment criteria.
- < "Comments" include other information used in interpreting the data for assessments, such as evidence that exceedance is solely due to natural conditions, or that the data does not meet the new "credible" data requirements.
- < In the "Summary Row" parameter exceedances are combined from multiple sites, and the assessment of each designated use is shown. The overall assessment for the surface water is described in the "Comments" field: "Attaining," "Not attaining," "Impaired," or " Inconclusive." See assessment criteria in Chapter III of Volume I.

Major ground water stressors – Monitoring data collected from wells in this watershed between October 1995-October 2000 are summarized in **Table 8** and illustrated in **Figure 12, 13, and 14.** As **Table 8** indicates, wells are sampled for different constituents.

As illustrated in **Figure 12** most of the wells sampled were part of two ADEQ ground water studies: the Virgin River Basin (1999) and the Hualapai Valley Basin (2001). These studies are discussed later in this Section. Note that radiochemical and metals were exceeded in both study areas, while nitrate and fluoride were exceeded only in the Hualapai Valley.

TDS concentration – Water quality can be characterized based on concentration of Total Dissolved Solids (TDS). High levels of salinity limits the practical uses of ground water in some areas of this watershed as TDS over 500 mg/L has an off-flavor (60% of the wells tested) and TDS over 1000 mg/L will limit its use for some crops (33% of the wells tested).

As illustrated in **Figure 13 and Table 8**, TDS is elevated in both ground water basins monitored. There appears to be a cluster of wells along the Virgin River with elevated salinity. The elevated levels of TDS do not present a human-health concern for drinking water use. The TDS concentration is only being used to generally characterize water quality.

Although no TDS ground water quality standard has been established in this watershed, a flow-weighted average annual salinity surface water standard is established on the Colorado River below Hoover Dam, below Parker Dam, and at Imperial Dam, just downstream of this watershed. These standards were established by Arizona as part of the federally administered Colorado River Basin Salinity Control Program, and these standards are being met. More information about the Colorado River Basin Salinity Control Program is provided in Section III of this report.

Nitrate concentrations – Water quality can also be characterized by looking at the concentration of nitrates in ground water **(Figure 14)**. Naturally occurring nitrate concentrations in ground water are generally below 3 mg/L. Concentrations above 5 mg/L indicate potential anthropogenic sources of nitrate. Of the 192 wells monitored for nitrate, 15% exceeded this 5 mg/L concentration.

When nitrate concentrations exceed 10 mg/L, Arizona's Aquifer Water Quality Standard has been exceeded. This standard was set to protect human health , as water with nitrate greater than 10 mg/L may present a health problem for babies and should not be consumed by nursing mothers. Only 2 of the 75 wells monitored (3%) exceeded 10 mg/L. Some monitored wells are irrigation wells (not used for drinking water); therefore, even these two wells may not represent a human-health concern. However, efforts need to continue to minimize further contamination of ground water by nitrate.

Table 8. Colorado-Grand Canyon Watershed Ground Water Monitoring 1996 - 2000

MONITORING DATA TYPE	PARAMETER OR PARAMETER GROUP	NUMBER OF WELLS			PERCENT OF WELLS EXCEEDING STANDARDS
		SAMPLED	SYNTHETIC CONSTITUENT DETECTED*	EXCEEDING STANDARDS	
INDEX WELLS	Radiochemicals	35		6	17%
	Fluoride	60		2	3%
	Metals/Metalloids	60		7	12%
	Nitrate	60		2	3%
	VOCs + SVOCs*	21	1	0	0%
	Pesticides	21	0	0	0%
TARGETED MONITORING WELLS	Radiochemicals	4		0	0%
	Fluoride	13		0	0%
	Metals/metalloids	14		0	0%
	Nitrate	15		0	0%
	VOCs + SVOCs*	0	---	--	--
	Pesticides	0	---	--	--

WELL CLASSIFICATION BY TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION				
Total Number of Wells	Wells <500 mg/L Acceptable drinking water flavor	Wells 500-999 mg/L Fresh (not saline) Some crop production problems	Wells 1000-3000 mg/L Slightly saline Increasing crop production problems	Wells >3000 mg/L Moderately saline to briny Severe crop production problems
64	26	17	20	1

WELL CLASSIFICATION BY NITRATE CONCENTRATION (measured as Nitrogen)			
Total Number of Wells	Wells <5 mg/L	Wells 5-10 mg/L May be an anthropogenic source of Nitrates	>10 mg/L Exceeds standards Should not be used for drinking water by babies or nursing mothers
75	64	9	2

*VOCs = volatile organic compounds; SVOCs = semi-volatile organic compounds.
*The detection of a synthetic constituent (pesticides, VOCs, and SVOCs) is noted because some do not have standards and these substances are not naturally occurring in the ground water.

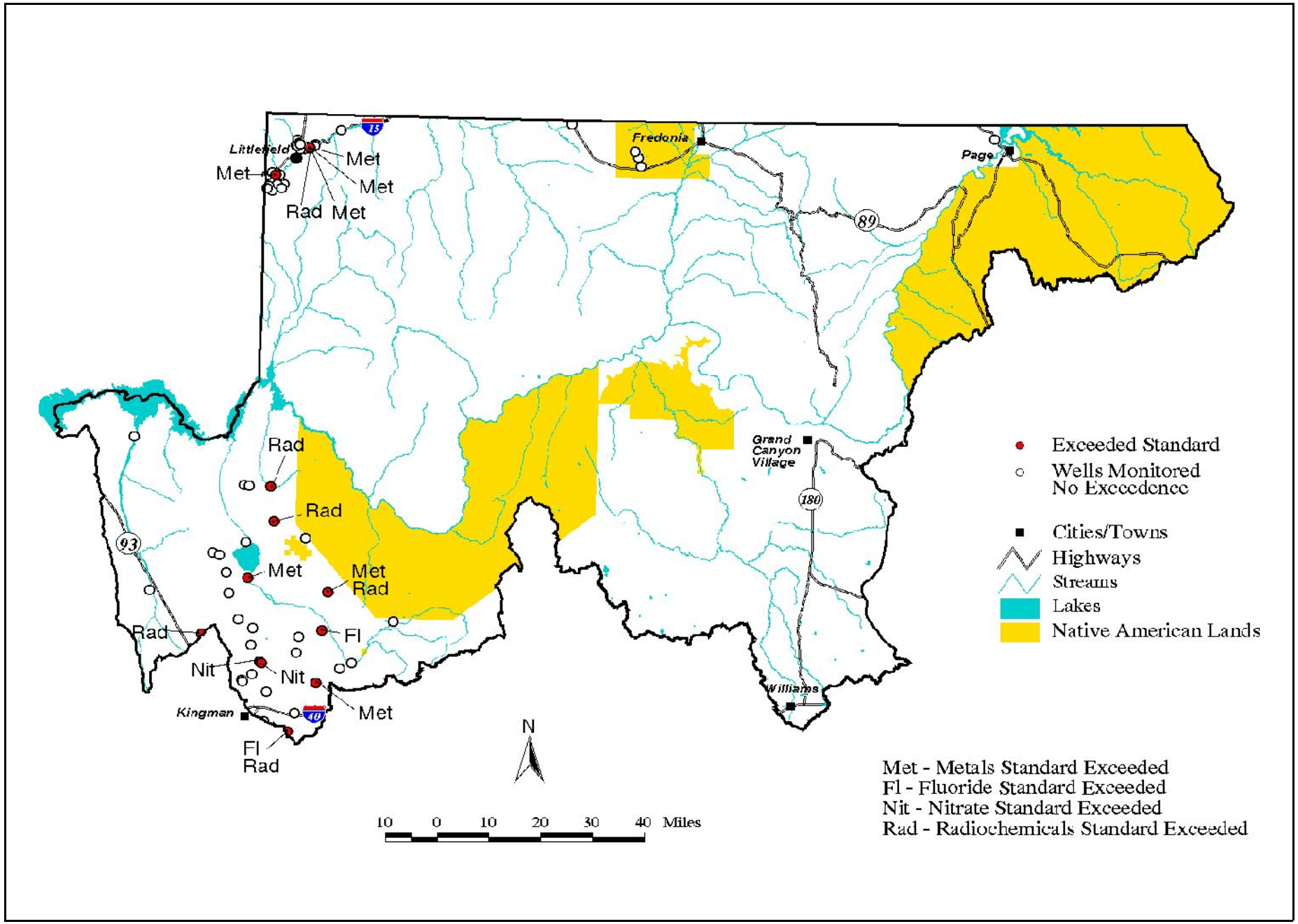

Figure 12. Ground Water Monitoring in the Colorado-Grand Canyon Watershed – 1996-2000

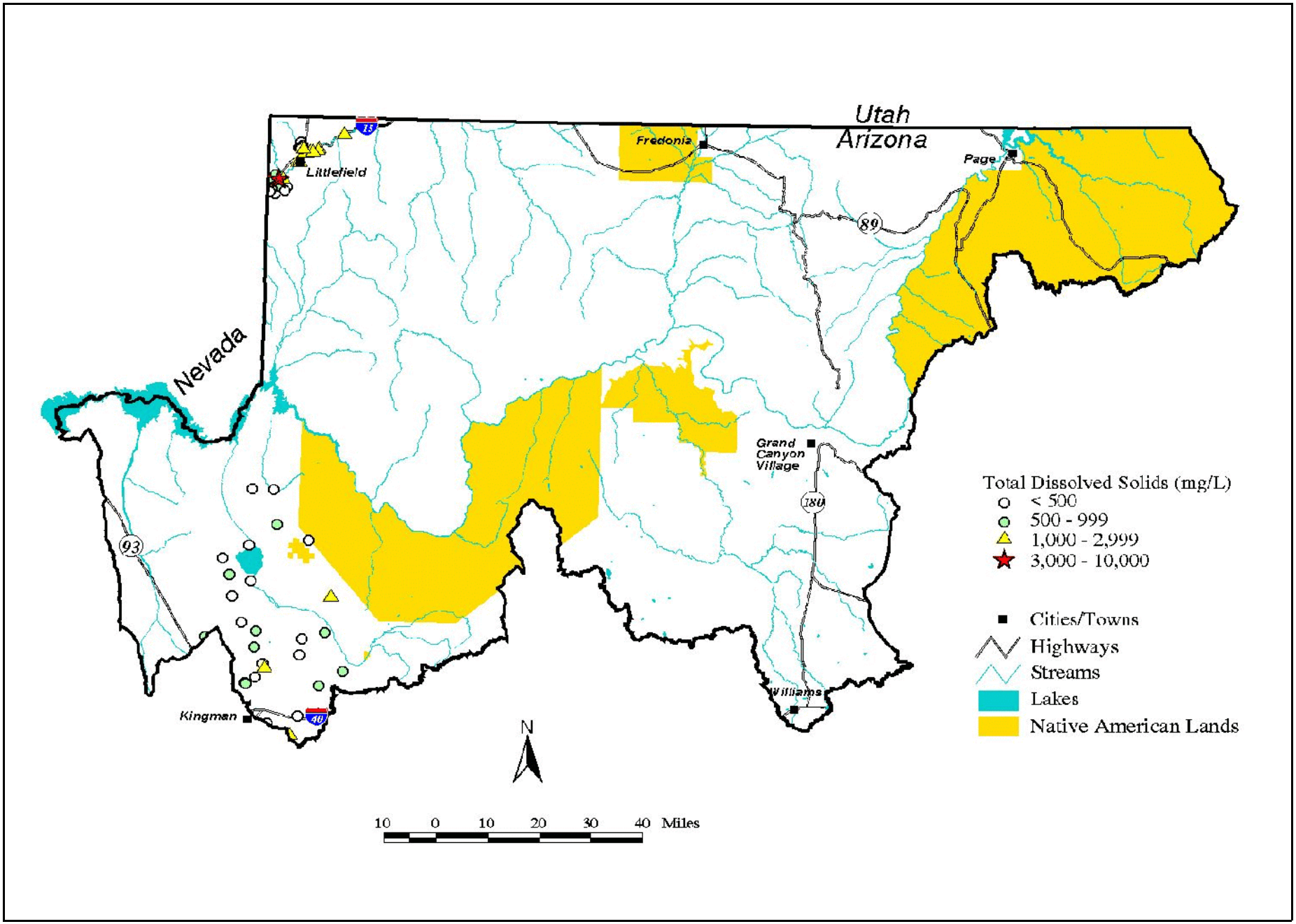

Figure 13. Classification of Ground Water Quality by TDS Concentration in the Colorado-Grand Canyon Watershed

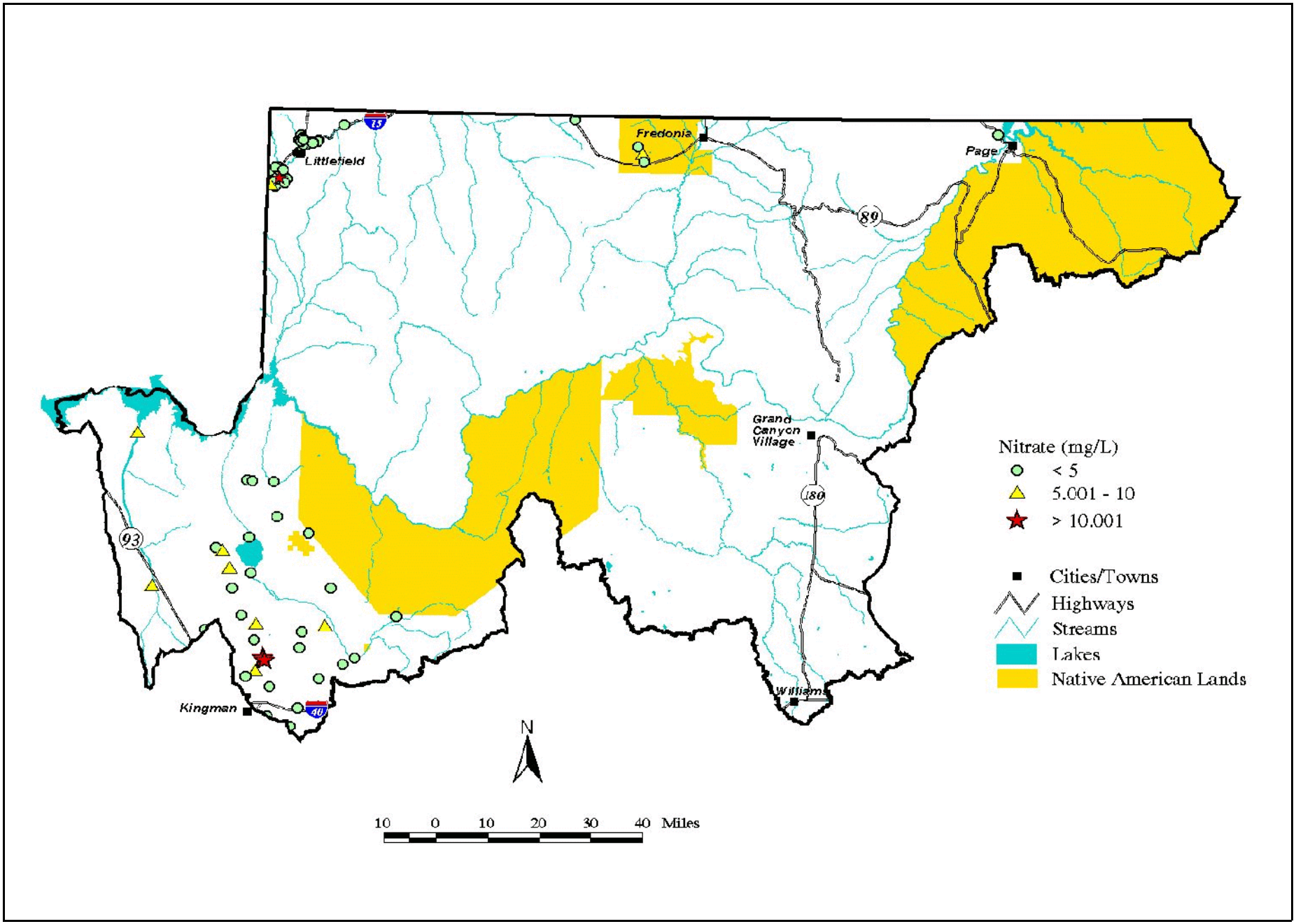

Figure 14. Classification of Ground Water Quality by Nitrate Concentration in the Colorado-Grand Canyon Watershed

Watershed Studies and Alternative Solutions in the Colorado-Grand Canyon Watershed

This section highlights surface and ground water studies, mitigation projects, and remediation activities which have been conducted to improve water quality in the Colorado-Grand Canyon Watershed. Watershed partnerships active in this watershed are also cited.

Surface Water Studies and Mitigation Projects

Total Maximum Daily Load Studies – The following TMDL analyses have been completed or are ongoing in this watershed. Further information about the status of these investigations can be obtained by contacting the TMDL Program manager at (602) 771-4468 or at ADEQ's web site: http://www.adeq.state.az.us/environ/water/assess/tmdl.html

http://www.adeq.state.az.us/environ/waters/assess.

< Paria River TMDL – In 1998, the Paria River was identified as impaired due to turbidity and beryllium, and subsequently included on the 303(d) List of impaired waters. The segment of concern is a 29 mile stretch from the Utah border to the Colorado River at Lee's Ferry. In October 1998, ADEQ developed a cooperative water quality monitoring effort with the Bureau of Land Management, and Northern Arizona University.

Eighty-five percent of the verification samples exceeded the applicable turbidity standard; however, this turbidity is due to a naturally high sediment load generated by the sandstone geology. Further, management practices are in place to minimize potential sources of sediment within the canyon.

The verification monitoring indicated no exceedances for beryllium. Based on this study, ADEQ is proposing to delist turbidity and beryllium. This would remove the Paria River from the 303(d) List of impaired waters.

Water Quality Improvement Grant Projects – ADEQ has awarded the following Water Quality Improvement (319h) Grants for projects in this watershed:

< The Greater Kingman Wildcat Dump Cleanup Project – This project is attempting to reduce wildcat dumping through education and outreach, and to cleanup eighteen wildcat dump sites in the Kingman area because of ground water contamination concerns.

This project was initiated on August 1, 2000, and has conducted workshops, created educational materials, solicited community participation, identified dump sites, and initiated the cleanup. An educational video and brochures have been developed. Brochures are distributed after the video presentations and target the hazards of illegal dumplings.

For more information regarding this project contact: Elno Roundy, Chairman, Northwest Arizona Watershed Council, P.O. Box 3222, Kingman, Arizona 86434.

< Abatement of Non-point Source Pollution at Spencer Beach on the Hualapai Reservation – Spencer Beach is located on the south side of the Colorado River at river mile 246, at the confluence of Spencer Creek with the Colorado River. It is a popular beach used for camping and picnicking by Colorado River rafters and power boaters from Lake Meade. However, this area lacked adequate sanitary human-waste facilities and trash facilities, which raised concerns that the beach and adjacent river water may become contaminated by fecal coliform and polluted with trash.

The project provided a new a composting restroom at the beach in 2000. The existing human waste buried in the beach sand was collected and removed during February 1999. The facility restroom was completed on April 29, 2000. Currently the restroom is reportedly receiving considerable use and the beach appears to remaining free from noticeable trash. The Hualapai tribe is conducting bacterial monitoring at the beach to determine the effectiveness of these

measures.

For more information regarding this project contact: Dr. Kerry Christiansen, Senior Scientist, Hualapai Department of Natural Resources, P.O. Box 300, Peach Springs, AZ 86434

< Milkweed Springs Sediment Control and Riparian Enhancement Project –Milkweed Springs is located along the headwaters of Spencer Creek (which discharges to the Colorado River), on the Hualapai Indian Reservation in northwestern Arizona. In this project structural sediment control measures were installed to minimize sediment due to discharges in the watershed and unpaved roads upstream of Milkweed Springs.

Check dams and filter dams were constructed in critical areas between a constructed gravel road and the riparian area associated with Milkweed Springs and Spencer Creek. During construction, prior to completion of all of the structures, flash flooding knocked out the temporary structures (which were designed to fail in very high flows) and washed away a front end loader belonging to the tribe. The project was finished and the washed out structures rebuilt in 2000. The structures are in place and functioning except for one temporary structure which had partial failure. Areas denuded during road construction were also restored by mulching and reseeding to reduce sediment discharge.

Implementation effectiveness has been measured quarterly through:

< Photo points to document visual changes,
< Flow rate and basic water quality measurements,
< Measurement of sediment trapped behind rock check dams.

More check and filter dams may be needed in the upper watershed, along with improvements in grazing management, to control sedimentation. This project was scheduled for completion in 2001. For more information regarding this project contact: Don Bay, Contracting Officer, Hualapai Department of Natural Resources, P.O. Box 300, Peach Springs, Arizona 86001

• Elimination or Reduction of Impairment to Red Springs, Moss Springs, and the Colorado River in Mohawk Canyon – The Hualapai Indian Reservation was awarded a grant to improve and maintain surface water quality impaired by elevated fecal coliform and sediment levels in the Mohawk Canyon drainage area through the removal of feral horses. The canyon covers 620 square miles in northwestern Arizona.

Fifty-two feral horses have been removed from Mohawk Canyon by helicopter net-gun capture and two fences have been added to keep horses from reentering the canyon; however, some wild horses remain in the canyon. These horses could have been missed during the roundup or gained reentry into the Canyon because the new fence at upper end of Mohawk Canyon was reportedly washed out. The Hualapai tribe intends to rebuild the damaged fence (at their expense).

Project administrators expect nearly 100% reduction of pollutants following the completion of this project. The Hualapai tribe is to measure the effectiveness of the project through photo-point documentation and water quality sampling to compare conditions before and after this animal removal project.

The completion of this project was scheduled for 2001. For more information regarding this project contact: Don Bay, Contracting Officer, Hualapai Department of Natural Resources, P.O. Box 300, Peach Springs, Arizona 86001.

Water Protection Fund Projects – Arizona Department of Water Resources provided Water Protection funds for the following projects.

• Protection of Spring and Seep Resources of the South Rim, Grand Canyon National Park by Measuring Water Quality, Flow, and Associated Biota – The Grand Canyon National Park received funds to make a hydrologic and biologic assessment (water quality, spring flora, and associated invertebrate fauna inventory) of twelve seeps and springs on the south rim of the Grand Canyon National Park. This assessment and a public outreach effort will be used to develop management objectives and strategies.

• Glen and Grand Canyon Riparian Restoration Project – The Grand Canyon Wildlands Council received a grant to:
  • Restore 10 acres of native cottonwood-willow habitat along the Colorado River at Lee's Ferry and

- Eradicate tamarisk from 63 tributaries in the Grand Canyon.

Colorado River Basin Salinity Control Program – See earlier discussion of research in the opening section of Volume II.

Human Waste Monitoring of Lake Powell – Glen Canyon National Recreation Area has historically had a problem with fecal material being deposited on and buried in the sandy beaches of Lake Powell. Not only is waste on the beaches unsightly, fecal material may contain pathogens. Because of these concerns Glen Canyon national Recreation Area enacted a rule that requires campers within 1/4 mile of Lake Powell to have and use a device for containing solid human waste unless toilets are available on the beach.

In 1999, six sites were selected to monitor for human waste and determine the effectiveness of the rule (Munill, et al, 2001). Human wastes were counted and cleaned from sites at Romana Cove, Crosby Canyon, Hansen Creek, Moqui Canyon and Warm Creek Beach in Utah. After two years, more waste was being collected than in prior seasons. This may be due to the crew being more adept at locating the wastes.

Selenium Budgets for Lake Powell and the Upper Colorado River Basin – Selenium is a constituent of concern in water in the Colorado River Basin. Since the discovery in 1983 of wildlife deaths and deformities caused by selenium in irrigation drain water in Kesterson National Wildlife Refuge in California, the Department of Interior has investigated the quality of irrigation drain water from 26 projects in western United States. This research has identified the following conditions that individually or in combination may influence concentrations of selenium in irrigation drain water:

- A geologic source of selenium;
- Low rainfall and high evaporation; and
- Topographically closed areas (e.g., impoundments, backwaters).

The purpose of this study (Engberg, 1999) was to determine selenium sources above Lake Powell and selenium mobilization processes in effect.

Based on data collected by the Bureau of Reclamation between 1985-1994, 83% of the selenium entering Lake Powell is accounted for at the output site (flows through the lake). The rest may be incorporated by the lake sediment or used by the biota. Of the selenium that reaches Lake Powell, the Gunnison River Basin produces an estimated 31% and the Grand Valley in Colorado produces an estimated 30%. Irrigation related activities are thought to be responsible for mobilizing 71% of the selenium that reaches Lake Powell.

Selenium concentrations in water at Imperial Dam of the Colorado River upstream of the Mexico international border are similar to those at the output site of Lake Powell. Therefore, most selenium observed in downstream areas of the Colorado River probably are probably derived from the Colorado River watershed above Lake Powell.

Bacterial Monitoring of Lake Mead – The National Park Service collects water quality samples from four coves on Lake Mead in Nevada that get high recreational uses (Boxcar Cover, Sandy Cove, James Bay, and Middle Point). In addition, a sample is collected from Teakettle Cove, a low use cove in Nevada. Samples are analyzed for fecal coliform and *Enterococcus.*

Limnological Investigations of Lake Mead – The US Bureau of Reclamation has been conducted limnological investigations at the Boulder Basin of Lake Mead from 1990 - 1998. The purpose of these investigations were to:

- Collect water quality data that might indicate impacts of the wastewater and other drainage flowing to the Las Vegas Bay from Las Vegas Wash in Nevada;
- Characterize limnological conditions that might affect the quality of water as a public drinking water source;
- Develop new technologies for assessing limnological features of a reservoir relating to water quality; and
- Improve the general understanding of Lake Mead's ecology and its relationship to Colorado River systems (as the Colorado River flows through this large reservoir).

The report concluded that there are summertime oxygen sags due to decomposition of organic material, when *Chlorophyll a* and algae are at peak levels. Storm water runoff negatively impacts Boulder Basin as all parameters evaluated were elevated. No standards were exceeded.

Las Vegas Wash - Lake Mead Water Quality Standards Study – The Nevada Division of Environmental Protection completed a water quality

standards study for Las Vegas Wash and Lake Mead in 1998. The study proposed to establish control points along Las Vegas Wash and in Las Vegas Bay in Lake Mead. It also proposed to add aquatic life standards (excluding fish) to the wash and eventually protect Las Vegas Bay for fishing and swimming. Some of the proposed changes included:

- Change pH from 7.0 - 9.0 to 6.5 - 9.0 Standard Units;
- Replace Total Filterable Residue with Total Dissolved Solids;
- Decrease the nitrate standard from 10 mg/L to 5 mg/L;
- Add *Escherichia coli* standards of: 235/100 ml (single sample maximum) and 126/100 ml (30-day geometric mean).

Ground Water Studies and Mitigation Projects

Virgin River Basin Study– The Virgin River Groundwater Basin, located in the northwestern corner of Arizona, encompasses more than 430 square miles. ADEQ conducted a regional study of the this basin in 1997. The Virgin River is a free-flowing major tributary of the Colorado River from its headwaters in Utah to Lake Mead in Nevada. It is characterized by high turbidity and salinity. The Virgin River's largest tributary in Arizona is Beaver Dam Wash, which is perennial for approximately one mile above its juncture with the Virgin. Ground water is the primary source for municipal, domestic, and livestock uses; however surface water is also used for irrigation. Four aquifers were examined in this study. Each aquifer sampled has a unique ground water composition which appears to be related to hydrological and geologic conditions within the basin.

- Beaver Dam Wash Aquifer – This aquifer consists of unconsolidated silt, sand, and gravel deposited between steep terraces created by the incision of Beaver Dam Wash. The relatively low parameter concentrations characteristic of the Beaver Dam Wash Aquifer are likely related to the high quality surface water in Beaver Dam Wash.
- Littlefield Aquifer – This aquifer is located below the town of Littlefield, and is comprised of alluvial-fan deposits that rest on a limestone formation. This horizontal limestone unit is overlain by alluvial fan deposits and is the likely cause of this saline and very hard ground water.
- Virgin River Alluvial Aquifer -- This aquifer consists of the flood plain and terrace alluvium southwest of Littlefield, along the Virgin River. The relatively high parameter concentrations characteristic of the Virgin River Alluvium Aquifer are likely influenced by the saline surface flow of the Virgin River. Factors influencing the Virgin River salinity include an initial high salt concentration, saline spring discharges near the community of Littlefield, and irrigation return flows.
- Virgin River Basin Aquifer – This aquifer is composed of the alluvial fan deposits of the Virgin Mountains south of the Virgin River. It exhibits a mixed chemistry. In contrast to other aquifers, the relatively low parameter concentrations characteristic of the Virgin River Basin Aquifer are likely the result of high quality, recharge from the Virgin Mountains.

Interpretation of these results suggest that ground water in the Virgin River Groundwater Basin supports drinking water uses as only one well exceeded an state aquifer water quality standard. However residents (particularly those utilizing the Littlefield Aquifer or the Virgin River Alluvial Aquifer) may prefer to install water treatment units for domestic use or to obtain domestic water from alternative sources for aesthetic reasons as 25 of the 38 wells sampled (66%) exceeded aesthetic-based criteria. Nitrate, with a few exceptions, was found at levels indicating minimal impact from human activities. These findings suggest that for domestic or municipal use, relatively shallow wells should be used in the Beaver Dam area while deeper wells should be used near the Virgin River.

Ground water Reconnaissance Survey in Mohave County: The watersheds (Sacramento Valley, Big Sandy Valley, Detrital Valley and Hualapai Valley) are all to the south of the Colorado River.

The University of Arizona has been commissioned by the Northwest Arizona Watershed Council (under the Arizona Rural Watershed Initiative) to catalogue the water resources of Mohave County in the Sacramento Valley, Hualapai Valley, Big Sandy Valley, and Detrital ground water basins. This research has two key components:

- To collect all relevant hydrologic data and information into one single source that can then be used by anyone doing any research or contractual work in the region in the future. This includes but is not limited to; Previous estimates of aquifer size, all publicly available studies, Depth to water, drawdown, rainfall measurements, recharge estimates and soil maps.

- To provide a preliminary hydrologic assessment based on the information obtained. This includes an assessment of earlier work to compare and attempt to explain why different aquifer parameters were used by different studies to come up with different figures.

Although this project is Phase I of a multi-phase project, it is anticipated that the result of this study will minimize data collection for others working in Mohave County (e.g., universities, government agencies, or private companies).
For more information contact: Gavin Fielding, Researcher, School of Renewable Natural Resources, 325 Biosciences East, University of Arizona, Tucson , AZ 85721 (gavinfielding@lycos.com) or (520) 621-5211 (for messages only). Fax: (520) 621-8801

Watershed Partnerships

Northwest Arizona Watershed Advisory Council – This council has been supported by the US Bureau of Land Management, and has identified the following key issues: wildcat dumping, ground water protection, and enforcement of existing environmental laws and regulations. This council has been responsible for the cleanup of two wildcat dump sites and is in the process of cleaning up two more sites. For information about group meetings, contact Elno Roundy (cleo@ctax.com).

Lake Mead Water Quality Forum – The Nevada Division of Environmental Protection established this public forum for discussion of water quality related issues pertaining to Las Vegas Wash (Nevada) and Lake Mead. The Forum identified the critical water quality issues facing Lake Mead. In priority order, the issues are:

- Identification of contaminant sources;
- Define the plume;
- Establish Forum water quality goals;
- Determine wether recreation involving water contact is safe in Las Vegas Bay near the inlet of the wash;
- Determine whether fish consumption advisories needs to issue;
- Sediment loading to Las Vegas and its bay;
- Further characterization of wastewater flows and posting of advisories;
- Identification of contaminants which are responsible for endocrine disruption observed in carp.

The Forum supported the National Park Service in posting signs advising that swimming was not recommended in Las Vegas Wash (Nevada).

The Forum has established a centralized database of water chemistry data, assisted in the collection and analysis of sport fish, and acted as an educational resource to the public.

Lake Powell Memorandum of Understanding Group and its Technical Advisory Committee – In 1998, a Memorandum of Understanding among the National Park Service, the US Geological Survey, the US Bureau of Reclamation, the US Fish and Wildlife Service, the US Environmental Protection Agency, Utah Division of Water Quality, Utah Division of Wildlife Resources, Arizona Game and Fish Department and Arizona Department of Environmental Quality was established to provide a mechanism for coordinating programs and initiatives that relate to the protection and understanding of Lake Powell.

For information concerning meetings of the Technical Advisory Committee, contact Mark Anderson at mark_anderson@nps.gov or (928) 608-6377.